

viscosity change of the electrorheological fluid layer, with the aid of the flexible substrate which may be the plastic film such as PET (polyethylene terephthalate). The “flexible” herein means a nature in which the operator can feel or recognize the deformation by touching (in a sense defined by a typical range of the concept) the interest object.

[0031] (First Touch Panel Apparatus with Tactile Display Function) The above object of the present invention is achieved by a first touch panel apparatus with tactile display function, said touch panel apparatus comprising: an optically transparent touch panel disposed opposite to a display screen for outputting display light and for allowing an input operation of depressing a part of said optically transparent touch panel corresponding to a part of the display screen in which visual information was displayed, the visual information displayed as the display pattern on the display screen and the visual information being for prompting the input operation; and said tactile display device as described above disposed opposite to said optically transparent touch panel at a side different from another side where said optically transparent touch panel is directed toward the display screen.

[0032] According to the first touch panel apparatus with tactile display function, a part of the touch panel corresponding to the visual information displayed as the display pattern to prompt the input operation on the display screen is depressed, during the operation. That is, the operation to be performed is almost the same as the operation for the typical touch panel as seen in an ATM (Automated Teller Machine) for a bank, a ticket bending machine in a station, and so on.

[0033] Furthermore, the touch panel apparatus with tactile display function includes the tactile display device of the present invention. The touch panel apparatus according to the present invention operates as follows, for example.

[0034] In the tactile display device disposed on the information display surface (i.e. a surface contrary to another surface toward the display screen of the display device) of the touch panel apparatus, it is possible to present to the operator the tactile information corresponding to the visual information by means of the irradiation light which is the display light of the visual information displayed on the display screen.

[0035] For example, in the ATM, there is presented the tactily recognizable tactile information “0” to “9”, correspondingly to the visual information indicating “0” to “9”. The operator can operate the touch panel, while viewing the visual information displayed on the display screen, and feeling the reliable tactile impression (or the reliable impression for the operation) from the tactile information presented by the tactile display device. That is, according to the first embodiment of the touch panel apparatus with tactile display function, it is possible to realize the extremely high quality tactile impression, efficiently.

[0036] In another aspect of the first touch panel apparatus with tactile display function, the apparatus is further provided with a change addition device for further changing the viscosity of at least a part of said electrorheological fluid layer, if said at least a part of said electrorheological fluid layer is depressed.

[0037] In the tactile display device of the present invention, an after-touch-reaction may be important in addition to the tactile impression. For example, in the case that a

pressable button is displayed as the tactile information, it is difficult to judge whether or not the button is actually depressed, although it is possible to recognize the existence and the position of the button.

[0038] This aspect is particularly effective in such a case. The change addition device changes the viscosity at least part of the electrorheological fluid layer when this part is depressed. Therefore, it is possible to display the tactile information with the after-touch-reaction.

[0039] For example, once the operator actually depressed the pressable button tactily displayed, the change addition device detects a fact that the button is depressed, and changes directly or indirectly the intensity of the irradiation light toward the characteristic change layer, so that the pressable button, which has been hard, become softer. From this, the operator can recognize easily and reliably a fact that the pressable button is depressed. Incidentally, the tactile information with the after-touch-reaction presented by the change addition device is not limited to this embodiment, but includes a wide variety of the viscosity change of the electrorheological fluid which has any relationship with the operator's operation.

[0040] In another aspect of the first touch panel apparatus with tactile display function, the apparatus is further provided with a display device having the display screen and for displaying the visual information on the display screen.

[0041] In this aspect, since there is further provided with the display device having the display screen, it is easy to reduce work-load for a series of processings for displaying the display pattern on the display screen and presenting the corresponding tactile information and other processings. Therefore, it is possible to realize a further efficient touch panel apparatus with tactile display function.

[0042] (Second Touch Panel Apparatus with Tactile Display Function) The above object of the present invention is achieved by a second touch panel apparatus with tactile display function comprising: a tactile display device disposed on a display screen for outputting display light corresponding to a display pattern, said device comprising: (1) a pair of electrodes having a light transmissive property and disposed opposite to the display screen; (2) a characteristic change layer disposed between said pair of electrodes, said characteristic change layer having a light transmissive property, wherein at least one of conductivity and magnetic permeability of said characteristic change layer changes at each part on the display screen in response to intensity of the display light; and (3) an electrorheological fluid layer disposed between said pair of electrodes and opposite to said characteristic change layer, said electrorheological fluid layer having a light transmissive property, wherein viscosity of said electrorheological fluid layer changes at each part on the display screen in response to applied voltage applied through said characteristic change layer by said pair of electrodes; an optically transparent touch panel disposed between said tactile display device and the display screen and opposite to the display screen, said optically transparent touch panel allowing an input operation of depressing a part corresponding to a part of the display screen in which visual information was displayed, the visual information displayed as the display pattern on the display screen and the visual information being for prompting the input operation; and a change addition device for further